

We claim:

- 1 1. A method of generating transport overhead for a high-speed frame of data in a
2 synchronous optical communications network, said high-speed frame of data
3 including a plurality of low-speed frames of data, said method comprising:
4 receiving at least one indication of error count associated with one of said low-
5 speed frames of data;
6 determining an error count bit pattern representative of said at least one
7 indication of error count; and
8 inserting said error count bit pattern into a transport overhead for said high-
9 speed frame, where said error count bit pattern is inserted in at least one
10 portion of said transport overhead and where said at least one portion is
11 unused according to a standard that defines said high-speed frame.
- 1 2. The method of claim 1 wherein said standard that defines said high-speed frame
2 is the SONET standard.
- 1 3. The method of claim 2 wherein said at least one indication of error count includes
2 a B1 count.
- 1 4. The method of claim 2 wherein said at least one indication of error count includes
2 a B2 count.
- 1 5. The method of claim 1 further comprising inserting a parity bit for said error count
2 bit pattern into said transport overhead, where said parity bit is inserted in another
3 portion of said transport overhead where said another portion is unused according to
4 said standard that defines said high-speed frame.
- 1 6. The method of claim 1 further comprising:
2 receiving an indication of synchronization status associated with one of said
3 low-speed frames of data;

determining a synchronization status bit pattern representative of said indication of synchronization status; and

inserting said synchronization status bit pattern into said transport overhead for said high-speed frame, where said synchronization status bit pattern is inserted in at least one portion of said transport overhead and where said at least one portion is unused according to said standard that defines said high-speed frame.

7. The method of claim 1 further comprising:

associating a channel identifier with each of said plurality of low-speed frames of data;

determining a channel identification bit pattern representative of said channel identifier; and

inserting said channel identification bit pattern into said transport overhead for said high-speed frame, where said channel identification bit pattern is inserted in at least one portion of said transport overhead and where said at least one portion is unused according to said standard that defines said high-speed frame.

8. A device for generating transport overhead for a high-speed frame of data in a synchronous optical communications network, said high-speed frame of data including a plurality of low-speed frames of data, said device comprising:

an error count bit pattern generator for:

receiving at least one indication of error count associated with one of said low-speed frames of data; and

determining an error count bit pattern representative of said at least one indication of error count; and

a line overhead inserter, in communication with said error count bit pattern generator, for inserting said error count bit pattern into a transport overhead

for said high-speed frame, where said error count bit pattern is inserted in at least one portion of said transport overhead and where said at least one portion is unused according to a standard that defines said high-speed frame.

9. A device for generating transport overhead for a high-speed frame of data in a synchronous optical communications network, said high-speed frame of data including a plurality of low-speed frames of data, said device comprising:

means for receiving at least one indication of error count associated with one of said low-speed frames of data;

means for determining an error count bit pattern representative of said at least one indication of error count; and

means for inserting said error count bit pattern into a transport overhead for said high-speed frame, where said error count bit pattern is inserted in at least one portion of said transport overhead and where said at least one portion is unused according to a standard that defines said high-speed frame.

10. A method of processing transport overhead for a frame of data in a synchronous optical communications network, said method comprising:

generating an error count by:

receiving a first low-speed frame;

calculating a first error monitoring set of bits based on said first frame;

receiving a second low-speed frame;

extracting a second error monitoring set of bits from a transport overhead of said second frame;

enumerating a number of differences between said first error monitoring set of bits and said second error monitoring set of bits as said error count; and

where a first performance of said generating gives an initial error count,
repeating said generating to give at least one subsequent error count;
summing said initial error count and said at least one subsequent error count
to give an accumulated error count; and
sending an indication of error count, based on said accumulated error count,
to a device for generating transport overhead for a high-speed frame of data
in a synchronous optical communications network, said high-speed frame of
data including a plurality of low-speed frames of data including said first low-
speed frame and said second low-speed frame.

11. A device for processing transport overhead for a frame of data in a synchronous
optical communications network, said device comprising:

an error monitor for generating an error count by:

receiving a first low-speed frame;

calculating a first error monitoring set of bits based on said first frame;

receiving a second low-speed frame;

extracting a second error monitoring set of bits from a transport
overhead of said second frame;

enumerating a number of differences between said first error
monitoring set of bits and said second error monitoring set of bits as
said error count; and

where a first performance of said generating gives an initial error count,
repeating said generating to give at least one subsequent error count;

a count accumulator for:

summing said initial error count and said at least one subsequent error
count to give an accumulated error count; and

17 sending an indication of error count, based on said accumulated error
18 count, to a device for generating transport overhead for a high-speed
19 frame of data in a synchronous optical communications network, said
20 high-speed frame of data including a plurality of low-speed frames of
21 data including said first low-speed frame and said second low-speed
22 frame.

1 12. A device for processing transport overhead for a frame of data in a synchronous
2 optical communications network, said device comprising:

3 means for generating an error count by:

4 receiving a first low-speed frame;

5 calculating a first error monitoring set of bits based on said first frame;

6 receiving a second low-speed frame;

7 extracting a second error monitoring set of bits from a transport
8 overhead of said second frame;

9 enumerating a number of differences between said first error
10 monitoring set of bits and said second error monitoring set of bits as
11 said error count; and

12 where a first performance of said generating gives an initial error count,
13 means for repeating said generating to give at least one subsequent error
14 count;

15 means for summing said initial error count and said at least one subsequent
16 error count to give an accumulated error count; and

17 means for sending an indication of error count, based on said accumulated
18 error count, to a device for generating transport overhead for a high-speed
19 frame of data in a synchronous optical communications network, said high-
20 speed frame of data including a plurality of low-speed frames of data including
21 said first low-speed frame and said second low-speed frame.

1 13. A method of combining a plurality of low-speed frames of data into a high-speed
2 frame of data such that error monitoring counts are transparently transferred to a
3 receiving network element, said method comprising:

4 receiving a set of low-speed frames on each of a plurality of channels;

5 generating an accumulated error count for each channel from a received set
6 of said plurality of low-speed frames on said each channel;

7 determining an error count bit pattern for said each channel based on said
8 accumulated error count for each channel; and

9 inserting said error count bit pattern into a transport overhead for said high-
10 speed frame, where said one said error count bit pattern is inserted in at least
11 one portion of said transport overhead and where said at least one portion is
12 unused according to a standard that defines said high-speed frame.

1 14. A combiner for combining a plurality of low-speed frames of data into a high-
2 speed frame of data such that error monitoring counts are transparently transferred
3 to a receiving network element, said combiner comprising:

4 for each of a plurality of channels, a low-speed transport overhead processor
5 for:

6 receiving a set of low-speed frames; and

7 generating an accumulated error count from said received set; and

8 a high-speed transport overhead generator, in communication with each said
9 low-speed transport overhead processor for:

10 determining an error count bit pattern for said each channel based on
11 said accumulated error count for each channel; and

12 inserting said error count bit pattern into a transport overhead for said
13 high-speed frame, where said one said error count bit pattern is
14 inserted in at least one portion of said transport overhead and where

15 said at least one portion is unused according to a standard that defines
16 said high-speed frame.

1 15.A combiner for combining a plurality of low-speed frames of data into a high-
2 speed frame of data such that error monitoring counts are transparently transferred
3 to a receiving network element, said combiner comprising:

4 means for receiving a set of low-speed frames on each of a plurality of
5 channels;

6 means for generating an accumulated error count for each channel from a
7 received set of said plurality of low-speed frames on said each channel;

8 means for determining an error count bit pattern for said each channel based
9 on said accumulated error count for each channel; and

10 means for inserting said error count bit pattern into a transport overhead for
11 said high-speed frame, where said one said error count bit pattern is inserted
12 in at least one portion of said transport overhead and where said at least one
13 portion is unused according to a standard that defines said high-speed frame.

1 16.A method of processing transport overhead for a frame of data in a synchronous
2 optical communications network, said method comprising:

3 receiving said frame of data;

4 extracting, from a transport overhead of said frame of data, an error count bit
5 pattern, where said error count bit pattern is extracted from at least one
6 portion of said transport overhead and where said at least one portion is
7 unused according to a standard that defines said frame;

8 determining an error count quantity from said error count bit pattern; and

9 indicating said error count quantity to an appropriate one of a plurality of
10 transport overhead generators.

1 17. The method of claim 16 wherein said standard that defines said frame is the
2 SONET standard.

1 18. The method of claim 17 wherein said at least one portion of said transport
2 overhead comprises at least one Z1 byte.

1 19. The method of claim 16 wherein said determining comprises dividing a value
2 represented by said error count bit pattern by a pre-determined integer value.

1 20. A device for processing transport overhead for a frame of data in a synchronous
2 optical communications network, said device comprising:

3 a channel information monitor for:

4 receiving said frame of data;

5 extracting, from a transport overhead of said frame of data, an error
6 count bit pattern, where said error count bit pattern is extracted from at
7 least one portion of said transport overhead and where said at least
8 one portion is unused according to a standard that defines said frame;

9 determining an error count quantity from said error count bit pattern;
10 and

11 indicating said error count quantity to an appropriate one of a plurality
12 of transport overhead generators.

1 21. A device for processing transport overhead for a frame of data in a synchronous
2 optical communications network, said device comprising:

3 means for receiving said frame of data;

4 means for extracting, from a transport overhead of said frame of data, an error
5 count bit pattern, where said error count bit pattern is extracted from at least
6 one portion of said transport overhead and where said at least one portion is
7 unused according to a standard that defines said frame;

means for determining an error count quantity from said error count bit pattern; and

means for indicating said error count quantity to an appropriate one of a plurality of transport overhead generators.

22. A method of generating transport overhead for a low-speed frame of data in a synchronous optical communications network, said low-speed frame of data received as part of a high-speed frame of data, said method comprising:

receiving at least one error count quantity associated with said low-speed frame of data, where said at least one error count quantity is determined from an error count bit pattern extracted from said high-speed frame of data;

determining a standard error monitoring set of bits based on a previous low-speed frame of data;

creating an altered error monitoring set of bits that differs from said standard error monitoring set of bits in a number of bit positions equivalent to said error count quantity; and

inserting said altered error monitoring set of bits into a transport overhead for said frame, where said altered error monitoring set of bits is inserted in a location normally occupied by said error monitoring set of bits according to a standard that defines said frame.

23. The method of claim 22 further comprising:

receiving an indication of a quantity of errors associated with said high-speed frame; and

where said determining said error count quantity is further based on said indication of said quantity of errors associated with said high-speed frame.

24. A device for generating transport overhead for a frame of data in a synchronous optical communications network, said device comprising:

3 a count processor for receiving at least one error count quantity associated
4 with said frame of data;

5 an error count generator, in communication with said count processor, for:

6 determining a standard error monitoring set of bits based on a previous
7 frame of data;

8 receiving said error count quantity from said count processor;

9 creating an altered error monitoring set of bits that differs from said
10 standard error monitoring set of bits in a number of bit positions
11 equivalent to said error count quantity; and

12 an overhead inserting device, in communication with said error count
13 generator, for inserting said altered error monitoring set of bits into a transport
14 overhead for said frame, where said altered error monitoring set of bits is
15 inserted in a location normally occupied by said standard error monitoring set
16 of bits according to a standard that defines said frame.

1 25. A device for generating transport overhead for a frame of data in a synchronous
2 optical communications network, said device comprising:

3 means for receiving at least one error count quantity associated with said low-
4 speed frame of data, where said at least one error count quantity is
5 determined from an error count bit pattern extracted from said high-speed
6 frame of data;

7 means for determining a standard error monitoring set of bits based on a
8 previous low-speed frame of data;

9 means for creating an altered error monitoring set of bits that differs from said
10 standard error monitoring set of bits in a number of bit positions equivalent to
11 said error count quantity; and

12 means for inserting said altered error monitoring set of bits into a transport
13 overhead for said frame, where said altered error monitoring set of bits is

14 inserted in a location normally occupied by said error monitoring set of bits
15 according to a standard that defines said frame.

1 26. A method of de-multiplexing a plurality of low-speed frames of data from a high-
2 speed frame of data, said method comprising:

3 receiving said high-speed frame;

4 extracting an error count bit pattern from said high-speed frame;

5 determining an error count quantity based on said error count bit pattern;

6 determining a standard error monitoring set of bits for a low-speed frame;

7 creating an altered error monitoring set of bits that differs from said standard
8 error monitoring set of bits in a number of bit positions equivalent to said error
9 count quantity; and

10 inserting said altered error monitoring set of bits into a transport overhead for
11 said low-speed frame, where said altered error monitoring set of bits is
12 inserted in a location normally occupied by said standard error monitoring set
13 of bits according to a standard that defines said low-speed frame.

1 27. The method of claim 26 further comprising:

2 determining a quantity of errors associated with said high-speed frame; and

3 where said determining said error count quantity is further based on said
4 quantity of errors associated with said high-speed frame.

1 28. A device for de-multiplexing a plurality of low-speed frames of data from a high-
2 speed frame of data, said device comprising:

3 a high-speed transport overhead processor for:

4 receiving said high-speed frame;

5 extracting an error count bit pattern from said high-speed frame;

6 determining an error count quantity based on said error count bit
7 pattern;

8 a low-speed transport overhead generator, in communication with said high-
9 speed transport overhead processor, for:

10 determining a standard error monitoring set of bits for a low-speed
11 frame;

12 creating an altered error monitoring set of bits that differs from said
13 standard error monitoring set of bits in a number of bit positions
14 equivalent to said error count quantity; and

15 inserting said altered error monitoring set of bits into a transport
16 overhead for said low-speed frame, where said altered error monitoring
17 set of bits is inserted in a location normally occupied by said standard
18 error monitoring set of bits according to a standard that defines said
19 low-speed frame.

1 29. A device for de-multiplexing a plurality of low-speed frames of data from a high-
2 speed frame of data, said device comprising:

3 means for receiving said high-speed frame;

4 means for extracting an error count bit pattern from said high-speed frame;

5 means for determining an error count quantity based on said error count bit
6 pattern;

7 means for determining a standard error monitoring set of bits for a low-speed
8 frame;

9 means for creating an altered error monitoring set of bits that differs from said
10 standard error monitoring set of bits in a number of bit positions equivalent to
11 said error count quantity; and

means for inserting said altered error monitoring set of bits into a transport overhead for said low-speed frame, where said altered error monitoring set of bits is inserted in a location normally occupied by said standard error monitoring set of bits according to a standard that defines said low-speed frame.

30. A communication system for transporting a plurality of channels of low-speed frames of data on a single channel of high-speed frames of data, said system comprising:

a combiner for combining said low-speed frames of data into a high-speed frame of data including:

for each of a plurality of channels, a low-speed transport overhead processor for:

receiving a set of low-speed frames; and

generating an accumulated error count from said received set; and

a high-speed transport overhead generator, in communication with each said low-speed transport overhead processor for:

determining an error count bit pattern for said each channel based on said accumulated error count for each channel; and

inserting at least one said error count bit pattern into a transport overhead for said high-speed frame, where said one said error count bit pattern is inserted in at least one portion of said transport overhead and where said at least one portion is unused according to a standard that defines said high-speed frame; and

a device for de-multiplexing said plurality of low-speed frames of data from said high-speed frame of data including:

23 a high-speed transport overhead processor for:

24 receiving said high-speed frame;

25 extracting said error count bit pattern from said high-speed
26 frame;

27 determining an error count quantity based on said error count bit
28 pattern;

29 a low-speed transport overhead generator, in communication with said
30 high-speed transport overhead processor, for:

31 determining a standard error monitoring set of bits for a low-
32 speed frame;

33 creating an altered error monitoring set of bits that differs from
34 said standard error monitoring set of bits in a number of bit
35 positions equivalent to said error count quantity; and

36 inserting said altered error monitoring set of bits into a transport
37 overhead for said low-speed frame, where said altered error
38 monitoring set of bits is inserted in a location normally occupied
39 by said standard error monitoring set of bits according to a
40 standard that defines said low-speed frame.

1 31. A computer data signal embodied in a carrier wave comprising:

2 a frame of data including a transport overhead;

3 where said transport overhead includes an error count bit pattern in at least
4 one portion of said transport overhead and where said at least one portion is
5 unused according to a standard that defines said frame.